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# An Algorithm for Treatment of Patients With Hypersensitivity Reactions After Vaccines

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## ABSTRACT

Concerns about possible allergic reactions to immunizations are raised frequently by both patients/parents and primary care providers. Estimates of true allergic, or immediate hypersensitivity, reactions to routine vaccines range from 1 per 50 000 doses for diphtheria-tetanus-pertussis to ~1 per 500 000 to 1 000 000 doses for most other vaccines. In a large study from New Zealand, data were collected during a 5-year period on 15 marketed vaccines and revealed an estimated rate of 1 immediate hypersensitivity reaction per 450 000 doses of vaccine administered. Another large study, conducted within the Vaccine Safety Datalink, described a range of reaction rates to >7.5 million doses. Depending on the study design and the time after the immunization event, reaction rates varied from 0.65 cases per million doses to 1.53 cases per million doses when additional allergy codes were included. For some vaccines, particularly when allergens such as gelatin are part of the formulation (eg, Japanese encephalitis), higher rates of serious allergic reactions may occur. Although these per-dose estimates suggest that true hypersensitivity reactions are quite rare, the large number of doses that are administered, especially for the commonly used vaccines, makes this a relatively common clinical problem. In this review, we present background information on vaccine hypersensitivity, followed by a detailed algorithm that provides a rational and organized approach for the evaluation and treatment of patients with suspected hypersensitivity. We then include 3 cases of suspected allergic reactions to vaccines that have been referred to the Clinical Immunization Safety Assessment network to demonstrate the practical application of the algorithm. *Pediatrics* 2008;122:e771–e777

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### Key Words

immunization, vaccines, hypersensitivity

### Abbreviations

MMR—measles-mumps-rubella

DTaP—diphtheria-tetanus-acellular pertussis

IgE—immunoglobulin E

HiB—*Haemophilus influenzae* type B

Tdap—tetanus-diphtheria-pertussis

MCV—meningococcal conjugate vaccines

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VACCINES, LIKE ALL other drugs, have the potential to cause allergic reactions.<sup>1–4</sup> Components that may be allergenic include the infectious agent or specific antigen(s), preservatives, stabilizers, and residual media used in preparation of the vaccine, as well as inadvertent contaminants that are introduced during vaccine handling. Individual vaccine components that have been implicated in acute vaccine reactions include egg protein, gelatin, and potentially other additives.<sup>5–7</sup> A list of potential allergens in currently available vaccines is maintained on the Institute for Vaccine Safety Web site ([www.vaccinesafety.edu](http://www.vaccinesafety.edu)).

Although egg allergy was hypothesized to be a cause of allergic reactions to measles, rubella, and measles-mumps-rubella (MMR) vaccines, children who are allergic egg tolerate MMR, and no significant amount of detectable egg protein is present in these vaccines.<sup>8</sup> Many MMR reactions are in fact attributable to gelatin allergy.<sup>9–12</sup> Egg allergy may be the cause of hypersensitivity reactions to influenza and yellow fever vaccines, which are grown on egg embryos (as opposed to chick embryo–derived fibroblast cells for MMR) and do contain residual egg protein.<sup>13,14</sup>

Gelatin allergy has also been shown to be a cause of allergic reactions to varicella, diphtheria-tetanus-acellular pertussis (DTaP), and Japanese encephalitis vaccines.<sup>15–23</sup> Allergy to yeast has been reported as a cause of reactions to hepatitis B vaccines,<sup>24</sup> and allergy to latex has also been suggested as a possible cause of vaccine reactions.<sup>25</sup> The risk for recurrent allergic reactions to a vaccine might be reduced by changing to a different manufacturer's product because of differences in components. For example, only 1 of several DTaP products contains gelatin.

The most useful system for classifying immunologically mediated reactions is based on timing, immediate or delayed. Most immediate reactions are type 1 hypersensitivity reactions that are mediated by preformed immunoglobulin E (IgE) antibodies against a vaccine component. These reactions typically occur within minutes of exposure

to the relevant allergen and almost always occur within 4 hours, with possible exceptions for delayed-onset reactions to rabies and Japanese encephalitis vaccines.<sup>17</sup> The most common symptoms of IgE-mediated allergic reactions are urticaria and angioedema, with less common symptoms including nasal congestion, cough, stridor, wheezing, shortness of breath, vomiting, abdominal pain, diarrhea, and hypotension. Anaphylaxis, an acute hypersensitivity reaction with multiorgan system involvement that can present as or rapidly progress to a severe life-threatening reaction, can also occur after vaccination.<sup>26</sup>

Delayed-type reactions occur hours to days after exposure.<sup>27</sup> The longest possible interval between exposure and the onset of symptoms is not completely clear, although most immunologists agree that reactions may occur up to 2 to 3 weeks after exposure. Most delayed reactions are classified as type 3 hypersensitivity and are attributed to formation of immune complexes, although other less well-defined mechanisms, including T cell-mediated processes, may also play a role. The most common signs of delayed-type reactions are rashes, which may include urticaria, erythema multiforme, and/or maculopapular eruptions. Although urticaria and angioedema are generally thought of as manifestations of immediate-type reactions, they can occur in delayed reactions as well. In the context of a delayed reaction, this is likely attributable to non-IgE-mediated processes such as complement activation by immune complexes, but late activation of the IgE system cannot be ruled out. Angioedema may also occur, especially in association with urticaria or erythema multiforme. Although uncommon, arthralgias, arthritis, joint swelling, serum sickness, and Henoch-Schönlein purpura may occur, as can a variety of other hematologic, renal, and gastrointestinal manifestations. Some delayed reactions may not be immunologically mediated. Persistent hard nodules at the injection site may involve irritant reactions, usually induced by adjuvants such as aluminum, and do not necessarily reflect immunologic hypersensitivity to vaccine constituents.

## APPROACH TO THE PATIENT

The approach to the patient begins with an assessment of the specific symptoms and the timing of those symptoms relative to vaccine administration. Immediate-type reactions are generally easier to identify and attributed to vaccine hypersensitivity because of the timing of the reaction and the characteristic allergic symptoms. In addition, it may be possible to identify the causative agent through skin testing or in vitro measurement of allergen-specific IgE. The most common reasons for misdiagnosis or confusion about possible immediate-type reactions include localized swelling near the injection site that appears urticarial, urticaria or other rashes that may be attributable to other causes, and syncope as a result of vasovagal reactions.

It is typically much more difficult to attribute clearly delayed-type reactions to the administration of a vaccine. Most of the signs and symptoms of delayed-type reactions are nonspecific and can be caused by other

factors, including intercurrent infections. Patients must therefore be carefully evaluated for other causes of their symptoms before any conclusion is made about the possible association with the vaccine(s). Because delayed-type reactions are not mediated by IgE antibodies, immediate-type skin tests or in vitro studies are not of value to identify the causative antigen or vaccine constituent. Other laboratory tests have not proved reliable in diagnosing non-IgE-mediated hypersensitivity reactions, leaving the clinician to rely on the timing of the reaction and the signs and symptoms to make a presumptive diagnosis.

The diagnostic approach will therefore differ depending on whether the suspected reaction is more consistent with an immediate or delayed reaction. For immediate-type reactions, skin testing and/or serum IgE testing, as described in detail in the next section, should be used in an effort to identify the presence of allergen-specific IgE to the vaccine or a specific vaccine component. Although both false-positive and false-negative results may occur, this testing can be extremely helpful in assessing risk regarding future immunization, and thereby minimizing the risk for anaphylaxis. This is particularly important with immediate reactions because subsequent IgE-mediated reactions on reexposure may be more severe than those seen in the initial presentation. Treatment decisions for patients with suspected delayed-type reactions, including the administration of future vaccinations, will be left to clinical judgment in most situations.

When deciding on administering additional doses of a vaccine that has been temporally associated with a hypersensitivity reaction, the risks for immediate and delayed type reactions differ considerably. IgE-mediated reactions have far more potential to cause life-threatening symptoms, such as airway obstruction, hypotension, and full-blown anaphylaxis. Although non-IgE-mediated delayed-type reactions may be very uncomfortable, they are rarely dangerous. Severe complications are unlikely when another delayed-type reaction occurs, and the occurrence of a delayed-type reaction to a vaccine does not predispose to an immediate hypersensitivity reaction with repeat exposure.

## ALGORITHM FOR PATIENTS WITH SUSPECTED IMMEDIATE HYPERSENSITIVITY REACTIONS

Although several protocols have been proposed for evaluation and revaccination after suspected allergic reactions,<sup>1,5,28</sup> none has undergone careful study. Our working group has formulated the algorithm (Fig 1) as a practical tool for the clinician in the evaluation and management of suspected reactions. The algorithm begins by making a determination as to whether the suspected reaction is consistent with an immediate-type reaction by taking a detailed history as described in Table 1.

On the basis of the history, the clinician must make a judgment as to whether the symptoms actually represent a reaction to the vaccine and, if so, whether it was possibly IgE-mediated. Many patients have symptoms that are mistakenly assumed to be caused by allergy, such as fainting, but there is no evidence of a true

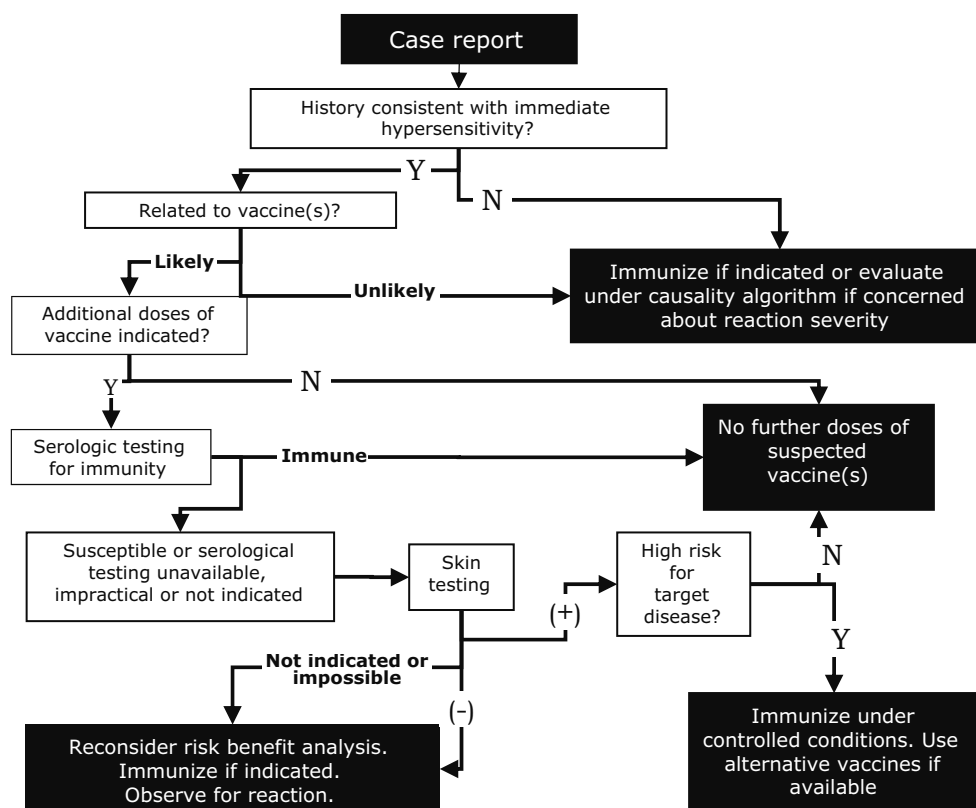


FIGURE 1  
An algorithm for the management of suspected allergic reactions to vaccines.

immediate hypersensitivity reaction. These patients can be revaccinated in appropriate settings, with a waiting period of at least 15 minutes as per the guidelines of the Advisory Committee on Immunization Practices.<sup>26</sup> For patients with signs and symptoms consistent with IgE-mediated reactions, allergy testing may be indicated, especially when future doses of the suspect vaccine(s) will be needed (Fig 1). Both skin testing and testing for specific IgE antibodies in serum have been used for the diagnosis of allergic reactions related to MMR, influenza, DTP, varicella, and pneumococcal polysaccharide (Pneumovax [Merck and Co, Whitehouse Station, NJ]) vaccines, as well as for the diagnosis of egg and gelatin sensitivity. Unfortunately, the sensitivity and specificity

of skin testing and in vitro tests for vaccine allergy have not been determined, largely because of the lack of adequately powered studies. For most vaccines, the clinician must rely on testing to the intact vaccine, whereas in some instances, specific vaccine components are available for testing (Table 2). Skin testing or radioallergosorbent testing for thimerosal sensitivity has not proved useful. Patch testing has been reported to be more useful for thimerosal hypersensitivity, although the true value of this procedure is far from clear.<sup>6</sup>

In most instances, skin testing should be conducted through referral to an allergist, although some appropriately trained primary care providers may be qualified to do this testing. When there is a convincing history of anaphylaxis, start with a skin-prick test using a 1:10 dilution (step 1); otherwise, start with step 2:

1. A skin-prick test by using a 1:10 dilution of the vaccine(s) or components (eg, egg, gelatin) should be conducted. Appropriate positive (histamine) and negative controls should be applied, and the tests should be read in 15 minutes. No additional testing will be done to any reagent that elicits a positive response, defined as a wheal at least 3 mm greater than the negative control, surrounded by a flare. If a wheal is seen without flare, then generally this is a negative test and the next dose should be tested.
2. A skin-prick test by using the full-strength vaccine should then be applied for any vaccines or compo-

TABLE 1 Key Historical Data

Patient's age
Specific symptoms that were noted
Timing of onset of the symptoms relative to the administration of the vaccine
Other exposures to possible allergens
Any information from office visits/emergency department visits
Treatment that was administered
Duration of symptoms, time course of resolution
Previous vaccine history
History of other atopic disease, including food allergy, drug allergy, atopic dermatitis, asthma, and allergic rhinitis
Specific vaccine(s) that was administered, including the manufacturer and lot number

**TABLE 2 An Approach to Skin and In Vitro Testing for Specific Vaccines**

Vaccine <sup>a</sup>	Skin Testing <sup>b</sup>	In Vitro IgE Testing <sup>c</sup>
DTaP	DTaP, DT, tetanus toxoid, gelatin <sup>b</sup>	Gelatin
DT	DT, tetanus toxoids	
Tdap	DTaP, DT, tetanus toxoid	
Hepatitis A	Hepatitis A	
Hepatitis B	Hepatitis B, yeast <sup>d</sup>	Yeast
HiB	HiB	
HPV	HPV, yeast	Yeast
Influenza	Influenza, egg, <sup>d</sup> gelatin <sup>e</sup>	Egg, gelatin
MCV	MCV	Egg, gelatin
MMR	MMR, measles, mumps, rubella, gelatin, <sup>b</sup> egg <sup>d</sup>	
MMR-V	MMR-V, egg, <sup>d</sup> gelatin, <sup>b</sup>	Egg, gelatin
Polio (IPV)	IPV	
PCV7	PCV7, yeast	Yeast
PS23	Pneumovax 23	
Varicella or zoster	Varicella, gelatin	Gelatin
Yellow fever	Yellow fever, egg, <sup>d</sup> gelatin <sup>b</sup>	Egg, gelatin

A more comprehensive list of potential allergens can be found at Institute of Vaccine Safety Web site ([www.vaccinesafety.edu/components-allergens](http://www.vaccinesafety.edu/components-allergens)). HPV indicates human papillomavirus; IPV, inactivated poliovirus; PCV7, 7-valent pneumococcal conjugate vaccine; PS23, pneumococcal polysaccharide vaccine.

<sup>a</sup> Whenever possible, the same vaccine from the same manufacturer should be used.

<sup>b</sup> Only if present in the product associated with a reaction.

<sup>c</sup> For skin testing to egg and yeast (*Saccharomyces cerevisiae*), Food and Drug Administration (FDA)-approved extracts are commercially available. For gelatin, there are currently no FDA-approved extracts available for testing; however, food-grade gelatin was used successfully in previous studies.<sup>9</sup> In addition, porcine gelatin, which may be antigenically different from bovine gelatin, is used in vaccines, whereas bovine gelatin is somewhat more common in the food industry.

<sup>d</sup> These foods should be tested only percutaneously and not tested intradermally.

<sup>e</sup> Found in only 1 type of influenza vaccine (Fluzone [Sanofi Pasteur Inc, Swiftwater, PA]).

nents with a negative prick test at the 1:10 dilution. The tests should be read at 15 minutes. No additional testing will be done to any vaccine or component that elicits a positive response. Additional testing should not be performed with the individual components.

3. An intradermal skin test by using a 1:100 concentration of the vaccine(s) should then be applied for any vaccines that have not elicited a positive result to prick testing.
4. An intradermal skin test by using a 1:10 concentration of the vaccine(s) should then be applied for any reagents that have not elicited a positive result, unless it has been determined that a 1:10 concentration is too irritating to provide useful results. This is most likely to be the case for influenza vaccine.<sup>29</sup>

Intradermal skin testing should rarely, if ever, be performed by using undiluted vaccines, because irritant reactions are extremely common.<sup>29</sup> Even at a 1:10 concentration, some vaccines are too irritating to provide reliable results. This is especially true for influenza vaccine, for which more than half of patients in 1 study were found to have an irritant reaction at a 1:10 dilution.<sup>29</sup> It is also important to recognize that localized, delayed-type hypersensitivity reactions are common after testing with undiluted and 1:10 concentrations of many vaccines and are not diagnostic of an allergy.

In 1 study that focused on children who had other allergic diseases and were believed to be at higher risk for vaccine allergy, a skin-testing protocol was conducted to 1:10 and 1:100 concentrations.<sup>30</sup> A total of 369 children were tested to measles, influenza, and/or a variety of other vaccines, including varicella, mumps, rubella, and Japanese encephalitis. The authors concluded that, overall, testing at a 1:10 concentration was most useful in identifying children who were at risk for subsequent reactions to the vaccines tested.

Whenever possible, skin testing should be done by using the specific vaccine, from the same manufacturer, that is suspected of causing the reaction. In addition, the individual components of combination vaccines can be used whenever those are available, and individual components can be tested when available. A scheme for skin testing to specific vaccines is presented in Table 2 with 2 major caveats: first, vaccine components may vary from 1 manufacturer to another and specific protocols may need to be adjusted to account for these differences; second, if multiple vaccines were given, then testing will need to include all potential vaccines. An infant might therefore need to undergo the testing protocol for each of the individual vaccines (eg, DTaP, hepatitis B, *Haemophilus influenzae* type B [HiB, inactivated poliovirus, Plevnar] if all were given at the same visit after which a possible allergic reaction took place.

## REVACCINATION OF PATIENTS WITH SUSPECTED HYPERSENSITIVITY REACTIONS

Decisions about additional vaccination should be made on the basis of a case-by-case risk/benefit analysis as guided by the algorithm. The options for revaccination include (1) withholding subsequent doses of suspected or implicated vaccines for patients who have serologic evidence of immunity, are at low risk for disease or serious complications from disease, or are at risk for life-threatening complications from the vaccine, (2) revaccination with minimal precautions for patients without evidence of immediate hypersensitivity, (3) revaccination with alternative vaccines that do not contain the component to which the patient has evidence of allergy, or (4) revaccination with special precautions for patients who have incomplete immunity and are at risk for disease.

For patients with immediate-type reactions, the following protocol can be used to guide revaccination:

1. If the skin tests are negative and there is no history of anaphylaxis, then the patient can be given the vaccine in a single dose and observed for 1 hour.
2. Alternative preparations that do not contain the suspected antigen should always be used when available.
3. If testing has been inconclusive and multiple vaccines are potentially implicated, then the next series of vaccines should be done individually, on separate days, to lessen risk and potentially identify which vaccine caused the reaction.
4. If the skin tests are negative and there is a history of anaphylaxis or other reactions of particular concern,



then the patient should be given 10% of the dose of the full-strength vaccine and observed for 30 minutes to 60 minutes, depending on the patient's specific history. If there are no signs of a reaction, then the remainder of the vaccine can be given and the patient observed for 1 hour.

5. If the skin test is positive for the vaccine and/or 1 of its components and there is an absolute need for vaccination, then the patient should be given escalating doses of the vaccine as recommended by the American Academy of Pediatrics.<sup>1</sup> According to the *Red Book*, the immunization will be given only by using a suggested dose-escalating protocol "if immunization is considered warranted because of a person's risk of complications resulting from the disease." This protocol should be conducted as follows in a controlled setting (well-equipped clinic with skilled personnel or possibly in the ICU, depending on the history), with each subsequent dose being given at 15- to 30-minute intervals when there are no signs of an adverse reaction:
  - a. 0.05 mL of 1:10 dilution
  - b. 0.05 mL of full strength
  - c. 0.10 mL of full strength
  - d. 0.15 mL of full strength
  - e. 0.20 mL of full strength

For vaccines that require a volume of 1.0 mL, the remaining 0.5-mL dose can be added. The question of interval between doses is not standardized and may need to be left open to clinical judgment, ranging from 15 to 30 minutes in general, but, for some cases, a 1-hour interval may be indicated when the interval for the original reaction was longer. The protocol should be aborted and treatment provided with any signs of an adverse reaction. Two options may subsequently be followed. One option would be to withhold additional doses of that vaccine. The second option that is used by some allergists would be the use of premedication with antihistamines and oral corticosteroids, as has been used with radiocontrast reactions,<sup>31</sup> although it is important to note that this has never been studied or proved effective for vaccine allergy.

6. After the 1-hour observation period, patients can generally return home unless a reaction has occurred.

Any patient who had positive skin tests and then successfully completes this protocol must still be considered to be allergic to the vaccine.

For patients with delayed-type reactions, the approach to revaccination will be based on the nature of the previous reaction, because skin testing will not be helpful in predicting future risk. If multiple vaccines are potentially implicated, then the next series of vaccines could be done individually, both to lessen risk and to identify better which vaccine caused the reaction if another reaction were to occur. The decision to revaccinate should be made on an individual basis, depending on the importance of revaccination and the nature of the pre-

vious reaction. Patients can generally receive the full dose of the vaccine and be observed for 1 hour in the unlikely event of an immediate-type reaction.

## CASE STUDIES: APPLYING THE ALGORITHM

### Case 1

A 12-year-old boy received tetanus-diphtheria-pertussis (Tdap) and meningococcal conjugate (MCV) vaccines and within 30 minutes developed hives and redness of his face and chest, wheezing, and throat tightness. He was given albuterol by inhaler by his mother and returned to the clinic, where he was treated with oral diphenhydramine and intramuscular epinephrine. His symptoms completely resolved over the next 2 hours. He had no history of food or drug allergy or previous adverse events after vaccinations. He did have a history of asthma and most recently had an acute exacerbation 3 months earlier.

This presentation, including both the timing and the specific symptoms, is very consistent with an immediate-type, IgE-mediated hypersensitivity reaction. Referral to an allergist for additional evaluation was recommended. Skin testing would be indicated to elucidate the cause of this reaction before the administration of future doses. Because this was an anaphylactic reaction, skin-prick skin testing would be initiated at a 1:10 dilution, followed by prick tests to the full-strength vaccines and then intradermal tests at 1:100 and 1:10 dilutions. An additional dose of Td is indicated in 10 years, or after 5 years if he has a penetrating injury that is considered to be a high risk for tetanus. Additional doses of MCV are not currently recommended; therefore, testing in the time frame immediately after the vaccine would be an option but was not absolutely needed, but skin testing should be performed before administration of future doses of Td (or Tdap or MCV if additional doses are ever recommended).

### Case 2

A 6-year-old boy received a second dose of varicella vaccine and within minutes developed flushing of his face and neck and complained of headache and abdominal cramping. His vital signs were normal, and his lungs were clear. Over the next 15 minutes he developed a pruritic rash on his chest and ears and swelling of his lower lip. He was given diphenhydramine, but the rash and swelling increased. He was given intramuscular epinephrine. The rash and other symptoms resolved over the next 30 minutes.

He received his first varicella vaccine at age 1 without problems, and he has no history of drug or latex allergy or previous vaccine reactions. He does have a history of Celiac disease. He has used topical neomycin (Neosporin [Johnson and Johnson Consumer Products, Langhorne, PA]) periodically without any reaction, and he has eaten gelatin with no difficulty. His mother declined additional testing, and no skin testing or specific IgE testing was performed. He needs a second dose of MMR, and the pediatrician consulted our group for advice on the risks of this vaccine. Our impression was that this reaction

was most likely an immediate-type, IgE-mediated hypersensitivity reaction to a constituent in the varicella vaccine, and we concurred with the pediatrician's concern about administering the MMR vaccine, because both vaccines contain gelatin. We believed that this probable allergic reaction to varicella vaccine was not an absolute contraindication to receiving the MMR but that testing should be performed before giving the MMR. We recommended measurement of his serum gelatin-specific IgE and MMR antibody levels. If MMR antibody levels are protective and there is evidence of sensitivity to gelatin, then the second dose of MMR should be deferred. If serologic studies indicate the need for MMR, then skin testing to MMR should be performed by using a full-strength prick test and sequential intradermal tests using 1:100 and 1:10 dilutions. Depending on skin test results and whether there is evidence of gelatin sensitivity, a discussion of the likelihood of a serious reaction versus the risk of withholding the vaccine should occur among the family, the allergist, and the primary care provider. Strategies for passive prophylaxis in the event of future exposure (eg, an outbreak of mumps at college) should also be considered.

### Case 3

A 1-year-old child received hepatitis A (dose 1), pneumococcal conjugate (dose 4), and HiB (dose 4) vaccines. The next day, she developed low-grade fever (38.2°C) and diffuse hives except on the palms and soles. She was taken to an urgent care clinic, where she was given acetaminophen and diphenhydramine. The fever resolved, but the hives persisted for 4 to 5 days. She did not have any other symptoms. She was previously healthy with no relevant medical history, allergies, or atopic disease.

The impression was that this most likely represented a serum sickness–like reaction, although an IgE-mediated, immediate-type reaction could not be ruled out. Also, an intercurrent infection could have caused the symptoms, which persisted for 5 days, and the vaccine may have played no role in the pathogenesis. We recommended checking hepatitis A titers and referral to an allergist for skin testing before her next hepatitis A dose, beginning with a prick test to the full-strength vaccine followed by intradermal tests at 1:100 and 1:10 dilutions. Skin testing could have been performed to the pneumococcal conjugate and Hib vaccines, but this was considered optional because no additional doses of those vaccines would be needed. Negative skin tests suggest that the patient is unlikely to have an immediate-type reaction with future doses; however, skin tests have not been shown to have predictive value for serum sickness–like or other types of non-IgE-mediated hypersensitivity reactions. As per the algorithm, if the skin test is positive, if she has hepatitis A antibody concentrations that are presumed to be protective, then we would withhold subsequent doses. If skin testing is positive but antibody concentrations are low and there is significant concern about the risk for hepatitis A exposure, then a graded rechallenge with hepatitis A vaccine in a controlled environment that has the personnel and equipment to

manage appropriately anaphylaxis or another serious adverse reaction would be recommended.

### CONCLUSIONS

Although the treatment of patients with suspected vaccine allergy is clearly an area in need of additional study, we have developed this algorithm and guidelines in the hope that they will provide clinicians with a framework on which patients with suspected reactions can be evaluated and treated. By use of a careful history and appropriate testing, most patients can be safely vaccinated or assured ongoing protection by the assessment of antibody titers. All suspected hypersensitivity reactions to vaccines, both immediate and delayed, should be reported to the Vaccine Adverse Event Reporting System ([www.vaers.hhs.gov](http://www.vaers.hhs.gov)) so that the true burden of this problem can be assessed.

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## An Algorithm for Treatment of Patients With Hypersensitivity Reactions After Vaccines

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